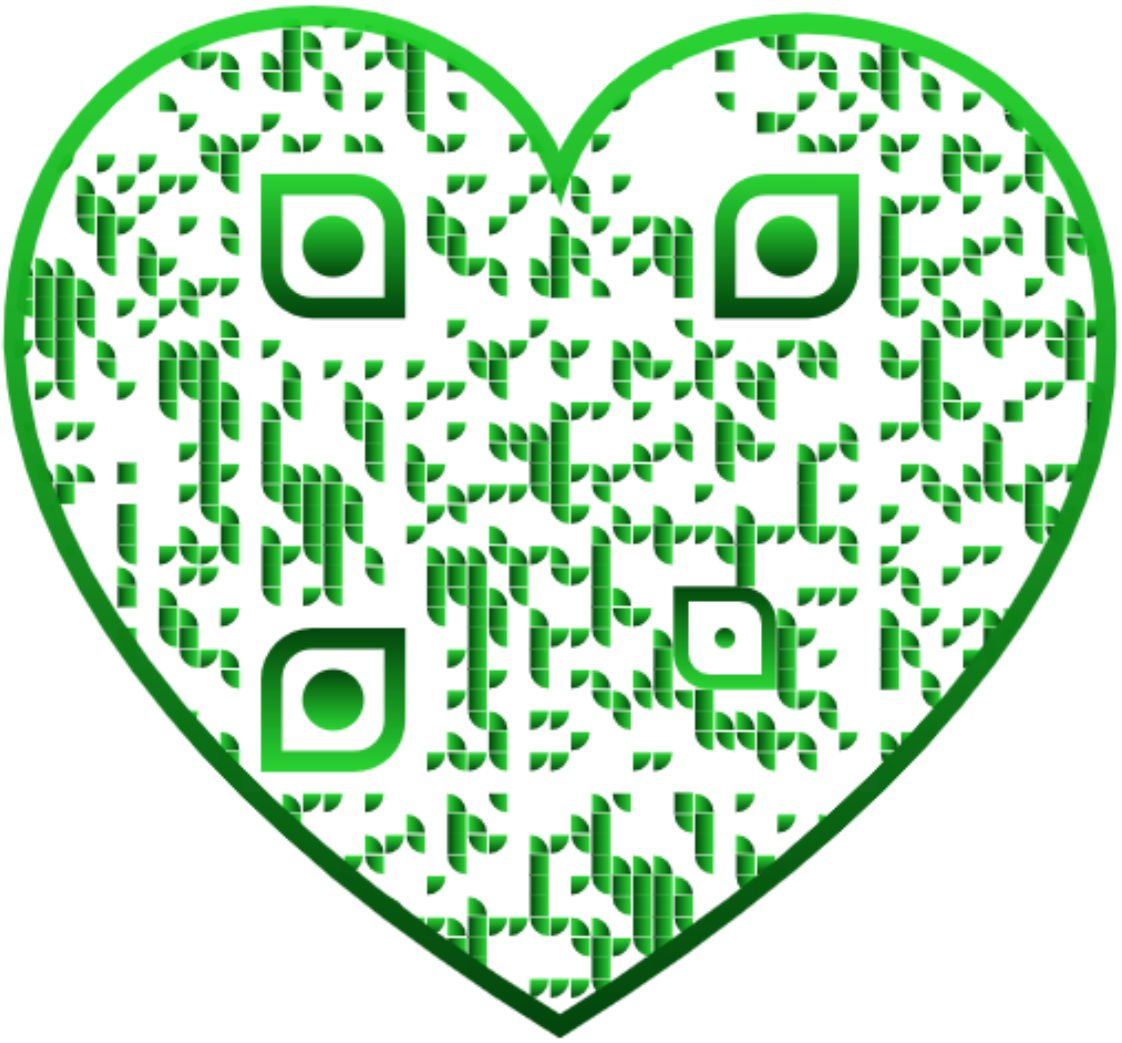
Precipitation Titration



Precipitation titration

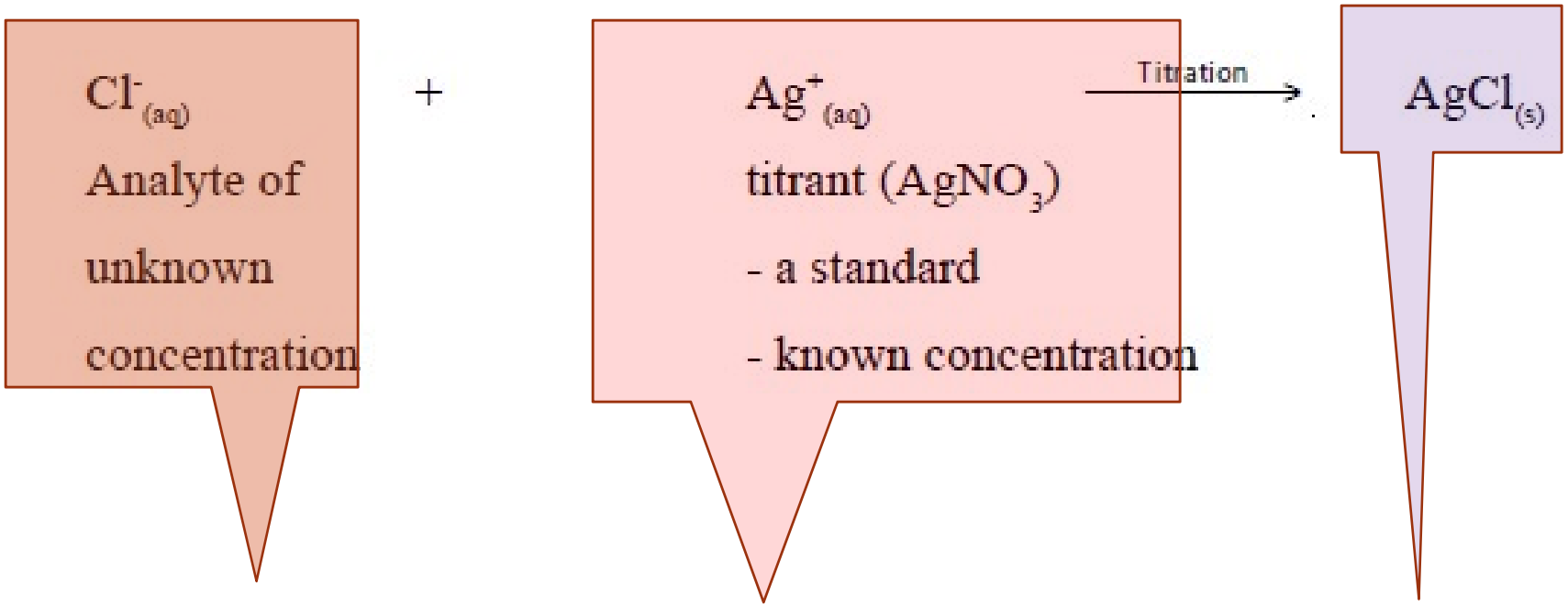
✓ Precipitation

- It occurs when two or more soluble species combine to form an insoluble product that we call a **precipitate. Or**
  - The formation of a slightly soluble solid from solution (the reverse of dissolution).
- A reaction in which the analyte and titrant form an insoluble precipitate also can serve as the basis for a titration. This type of titration is a **precipitation titration.**

✓ Precipitation titrations

- are based upon reactions that yield ionic compounds of limited solubility.
- The most important precipitating reagent is **silver nitrate.**
- Titrimetric methods based upon silver nitrate are sometimes termed **argentometric methods.**

Illustration: In the determination of chloride, 50 ml of a 0.1M AgNO3 solution would be required to completely react with 0.005 moles of chloride present in solution.



- Limitation of precipitation titration
  - Slow rate of reaction b/n the titrant & analyte
  - Lack of suitable indicator for many pptn titration
  - Difficult to obtain an accurate precipitate composition, the co-precipitation effect is often occurred.

- On the bases of the method used to identify the equivalent point, there are two common types of **argentiometric titration s**:

1. Mohor's method

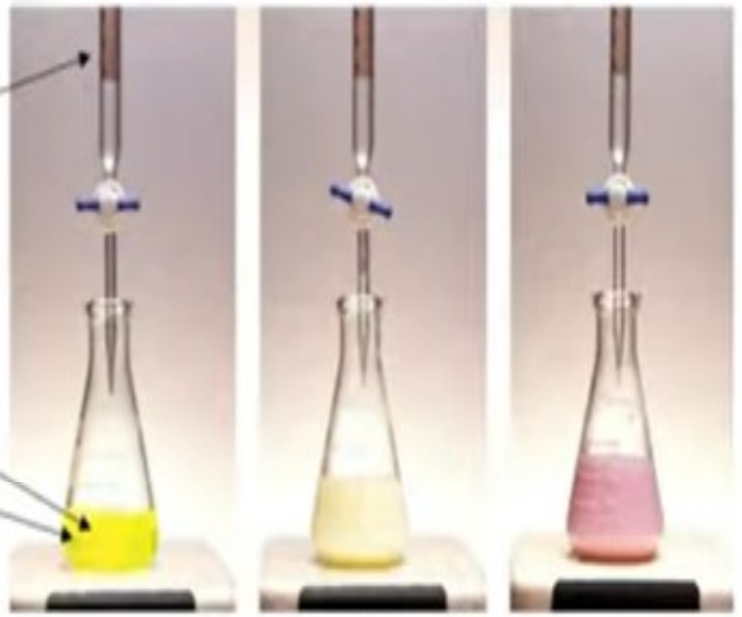
   - Titration to the appearance of a precipitate that differ in color from the original color

2. Volhard's method

   - Titration to the appearance of a soluble colored complex

Mohr's Method

- Measures $[Cl^-]$
- Titrant = $AgNO_3$ (burette)
- Analyte = Cl^- ions (conical flask)
- Indicator = K_2CrO_4 (conical flask)



Initial ① AgCl formed ② Ag_2CrO_4 formed **endpoint**

① $AgNO_3(aq) + Cl^-(aq) \rightarrow AgCl(s) + NO_3^-(aq)$

Excess $AgNO_3$ used for titration (2nd reaction)

② $AgNO_3(aq) + K_2CrO_4(aq) \rightarrow Ag_2CrO_4(s) + KNO_3(aq)$

Practice Question

Excess amount of a 0.0500 mol L^{-1} solution of silver nitrate is added to 50.00 mL of a solution containing an unknown concentration of chloride ions. Some amount of potassium chromate is added and used as the indicator. The endpoint of titration is marked by the formation of silver chromate ions according to the reaction:

Ans: 0.0185 M

$$2Ag^{+}(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s)$$

The average titre volume after 5 repeats is 18.50 mL.

Calculate the concentration of chloride, expressed in mol L^{-1}.

- Disadvantage:-
  - ✓Sulfides, phosphates and arsenates will also be precipitated
  - ✓The end **point** is less sensitive with dilute solution
  - ✓It cannot be used if the solution is acidic
    - ✓ In acidic solution K_2CrO_4 changed to chromic acid which cannot for a precipitate with Ag+

Volhard's Method

- Measures $[Cl^-]$
- Excess $AgNO_3$ is added to chloride solution
- Filtration: filtrate is titrated against NaSCN (burette)
- **Indicator:** $Fe(NO_3)_3$ (conical flask)

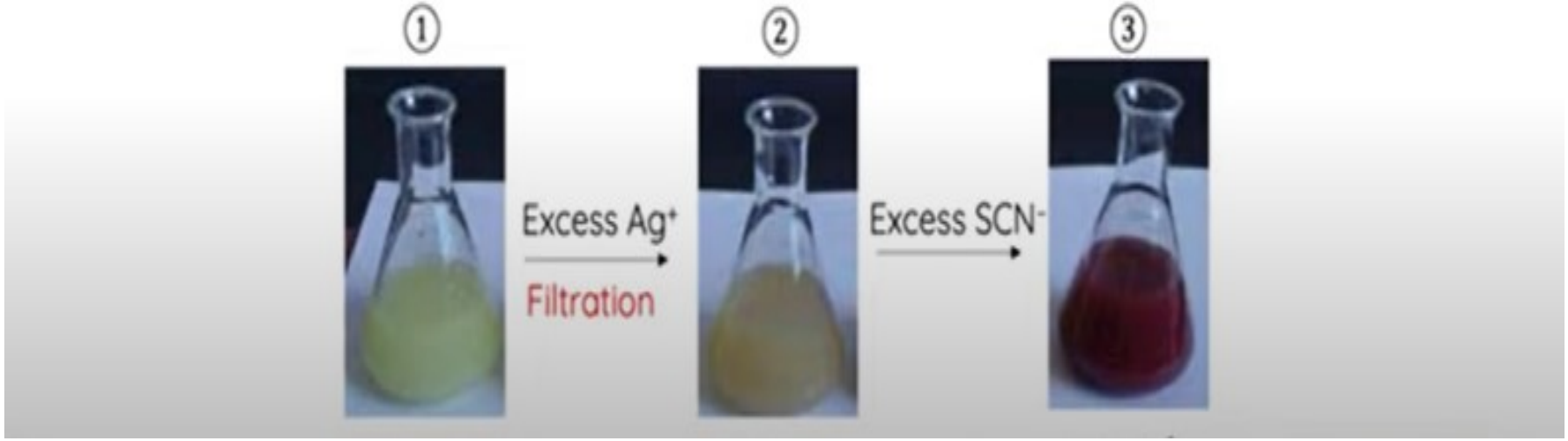
① $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

Filtrate | Excess Ag^+ used 2nd reaction

② $Ag^+(aq) + SCN^-(aq) \rightarrow AgSCN(s)$

Excess SCN^- used 3rd reaction

③ $Fe^{3+}(aq) + SCN^-(aq) \rightarrow FeSCN^{2+}(aq)$



AgCl(S) AgSCN (S) $[FeSCN]^{2+}$ (red soluble complex)

Practice Question

50.0 mL of a solution containing an unknown concentration of chloride ions is added to 50.00 mL of 0.0500 mol L^{-1} solution of silver nitrate.

The precipitate is filtered, and the filtrate is titrated with 0.0200 mol L^{-1} solution of sodium thiocyanate (NaSCN). The reaction is represented by the equation:

Ans: 0.04 M

$$Ag^{+}(aq) + SCN^{-}(aq) \rightarrow AgSCN(s)$$

The average titre volume after 3 repeats is 25.00 mL.

Calculate the concentration of chloride ions in the solution (in mol L^{-1}).

Application:

- NaCl given through IV infusion.
  - ✓ in determination of the % w/v NaCl.
- Potassium iodide
  - ✓ KI can be determined by direct titration with $AgNO_3$ using iodine & starch as indictor.

$$KI + AgNO_3 \qquad KNO_3 + AgI_{(ppt)}$$

  - ✓ At the end-point excess silver nitrate reduce the indicator, iodine, to iodide ion, destroyed the purple starch-iodine complex & leaving a pale yellow soln.

THE END